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# PARTICULARITIES OF RISK IN THE CASE OF EXTREME EVENTS

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***Abstract:*** *It is well known that the environment and human society are often affected by the action of extremely dangerous and diverse events, of both natural and anthropic origin, which can create destructive and brutal deregulation in certain given systems and situations.*

*A series of theoretical aspects regarding current catastrophic events are presented, as well as their global costs.*

*In the second part of the paper, hazards and their risk evaluations are presented, thus revealing the types of hazards, their effects, and their associated risk.*

***Keywords:*** *natural hazards, vulnerability, risk, risk evaluation, economic effects, social effects, ecological effects*

## 1. INTRODUCTION

It is well known that the environment and human society are often affected by the action of extremely dangerous and diverse events, of both natural and anthropic origin, which can create destructive and brutal deregulation in certain given systems and situations.

These events (earthquakes, volcanic eruptions, tsunamis, landslides, storms, floods, droughts, fires, technological accidents, conflictual situations, etc.) are generally unexpected, causing numerous victims both in the population and amongst animals, with a large volume of material damage, ecological unbalances, and even grave disturbances of psychic and moral state of the population affected by said phenomena.

Statistical data reveals that in the past three decades, on a planetary level, different disasters have caused the deaths of over eight million people, disease and suffering for over another billion, losses and destruction of material goods worth hundreds of billions of dollars. On average, annually, destruction causes 25000 deaths and approximately three billion dollars in economic damage.

The effective growth of naturally catastrophic events noticed in the present, as well as their global costs, can be attributed to several factors:

- cyclical episodes that govern different natural hazards;
- the global growth of population and its concentration;
- growth of vulnerability of human communities;
- negligence regarding foresight, insufficient measures and activities to prevent disasters;

- population's increased sensibility and demands, coming from an audience more and more preoccupied by threats to its safety and security

The main factor responsible for risk recrudescence is, in our opinion, the growth of vulnerability of human communities. Alongside natural characteristics that determine the degree of vulnerability, man creates or aggravates these vulnerabilities in the following ways:

- placement, for economic reasons, in vulnerable areas, increased urbanization and industrialization at exposed sites;
- occupying and frequenting risk-enabling environments, form and type of space usage;
- rising dependency of the urban environment on various technical networks, susceptible to perturbations, either anthropic (water and heating pipes destruction, electrical networks or telecommunication) or natural in nature;
- growing mobility in subterranean space in the service of urbanization (subway lines, tunnels, underground parkings, etc.) worryingly increase the specter of vulnerabilities;
- subversive behavior multiplication, delinquency (social factors) bring an additional dimension to vulnerability.

## 2. HAZARDS AND RISK EVALUATION

### 2.1 Hazard classification

Hazards can be classified by various criteria: origin, manifestation, frequency, damage, potential for damage, etc.

Classification by origin splits hazards in two large categories (Table 1, see end of paper).

*By mode of manifestation and period of installation,* hazards are classified in*:*

| | |
|---|---|
| | - earthquakes |
| | - volcanoes |
| **Violent hazard** | - typhoons, tornadoes etc. |
| | - local storms accompanied by hail, etc..<br>- catastrophic landslides, avalanches |
| **Progressive hazard** | - disturbances Mediterranean (Mediterranean cyclones retrograde evolution) |
| | - phenomena fry |
| **Slow hazards** | - droughts |
| | - mists of radiation and evaporation |

**Table 2.**

*Classification by damage (by Zavoianu, Dragomirescu, 1996):*

| | | |
|---|---|---|
| | casualties | at least 100 dead |
| by Sheehan, Hewit | | at least 100 injured |
| | damage to the economy | at least $ 1 million |
| | casualties | at least 200 dead |
| by Swiss Re | damage to the economy | at least $16,2 million |
| by Gares, 1994 | casualties | at least 200 dead |

**Table 3.**

By surface area, active duration, main effects (by Chardon, 1990):

- Giga catastrophe (volcanic explosions);
- Mega catastrophe (large earthquakes, volcanic eruptions, tropical droughts);
- Mezzo catastrophe (smaller volcanic eruptions, earthquakes with less intensity, cold waves, thunder storms, tornadoes);
- Catastrophe (small seismic, tornadoes, exceptional rainfall);

Spot localization phenomena (slope processes, muddy torrents, hail storms).

### 2.2 Hazard effects

Manifestation of different hazards creates effects on multiple layers, especially economic, social and ecological.

Economic effects can be best expressed by the damage, both real and potential, that hazards cause:

- real damage is represented by damage produced by the direct manifestation of a hazard can be direct (material destruction, housing, intervention costs, evacuation and healthcare) and indirect (losses recorded by the national economy at units unaffected by the hazard, but whose activity is perturbed by losing connections between them and units directly affected by the hazard)
- potential damage is the damage between the activities that would have taken place on a particular landfill (such as a riverbed) if it were not periodically affected by a hazard (ex: flood) and the results of activities effectively taking place there in the regime imposed by the hazard

Amongst the most important ecological effects we mention: modifications to land elevation, especially whereas balance and equilibrium of slopes, modifications to air quality and surface and subterranean water supplies, soil alteration, modifications to local flora and fauna, both on the ground and underwater, growing risk of endemic disease breakouts, and others. Ecological effects are entirely unquantifiable, and require relief (if at all possible) over extended periods of time.

Social effects of hazards have a much greater severity, whose elimination is a condition with direct implications over the general welfare of the population. They cannot be quantitatively expressed unless in exceptional circumstances.

### 2.3 Risk evaluation

The study and, more importantly, evaluation of risk is a complex and difficult undergoing considering the multitude of factors, parameters and variables that must be taking into account.

It must rely on an inter-disciplinary approach, both through natural and social studies

- probabilistic or deterministic approaches
- resorting to different resources and theories borrowed from mathematics (fractal geometry, Chaos Theory, probabilistic calculus)
- development by the SIG

Total control over risk is impossible, and it can be at best made more efficient through pragmatic approaches, particularly, normative and probabilistic, which are two complementary approaches, irreplaceable for this operation.

The probabilistic approach tries to anticipate the apparition of catastrophic events in a system's evolution, using probabilistic calculus to determine legitimises that govern risk and potential events. This kind of an approach reveals the proportion and cyclical nature of natural or socio-economic events. The main operations are uncovering factors that intervene in risk enabling and finding correlations between events to promptly discover the risky character of a situation.

A normative approach implies the establishing of norms, thresholds for certain risk factors and systems. Unfortunately, in geographic systems, being extremely complex, setting up clear thresholds is impossible. These thresholds should result from measurements, calculus, experiments and having public or legislative validation to be further respected. Some elements, like pollution, buildings' ability to withstand earthquakes, etc. have well defined standards, but thresholds for more complex geographical elements have yet to be established, particularly due to their difficulty.

Currently, the international community's efforts are focused on increasing responsibility of post-disaster reactions and measures and pre-disaster attitude and action.

A common means of risk evaluation is graphically representing its two features: probability and severity. If probability is equaled with frequency and gravity is given a set of numeric values, we obtain an F/N diagram (frequency/number). This way, damages can be represented graphically, according to the frequency and their numeric coordinates (figure 1).

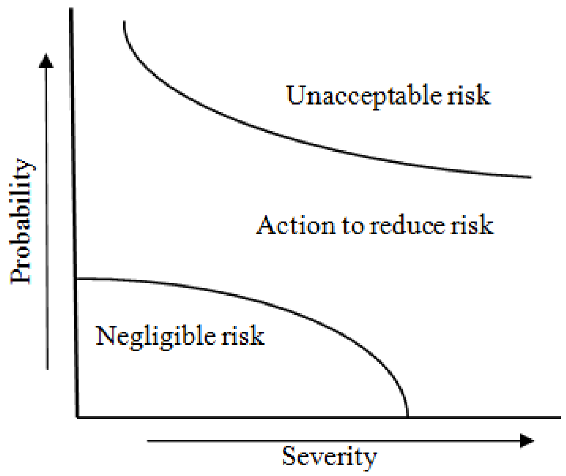


**Figure 1.**

As a planning device, the field can be separated into three action zones, according to the level of acceptability. If the graphic of the F/N value goes under the incidence of the "negligible" field, there is no need to allocate new resources to reduce the risk; if it falls in the middle area, resources must be redistributed to reduce risks; and finally, if it falls under unacceptable, efforts must be focused concertedly to find an alternative. Positions of these areas are creations of society and are not related to the nature of the risk itself. As the process implies an estimate scale, and this is surely a gross simplification, the accuracy of the results is reduced.

*Natural hazard risks study* implies an entire problematic that must allow for an objective analysis of the phenomenon, starting with rigorous observation of hazards and ending with evaluation of material costs to diminish consequences and reconstruction of destroyed goods and the environment.

Such a study encompasses a laborious activity, following several aspects:

- the existence and analysis of statistical data from an extended period of time
- establishing medium characteristics of each analyzed parameter
- extracting extreme values, as representations of possible variation limits of the phenomenon, as well as risk thresholds
- calculating the deviation of the respective parameter from the average, taken as normal
- defining the threshold from which a phenomenon becomes a risk
- defining and analyzing genetic factors for each studied risk
- analysis of the manifestation in time and space of said phenomenon
- defining the risk interval
- quantification of the degree of vulnerability (material damage and victims recorded as a result of the manifestation of such risks)
- psychological consequences and the role of education through mass-media
- monitoring risk factors
- evaluating material costs to diminish consequences and reconstruction costs of assets lost and of the environment

In quantifying these factors, the main criteria taken into account are: potential for destruction and severity of consequences (human victims, material damage), frequency (occurrence period) and the difficulty in preventing or diminishing effects.

*The study of ecological risks* encompasses two distinct steps. First, there is a localization investigation in order to discover what alterations have been brought to the environment or could take effect (risk analysis), and secondly, which alterations can be tolerated (risk assessment).

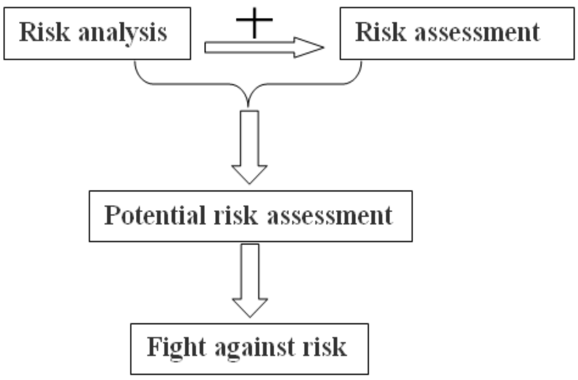


**Figure 2.**

So, with the help of these two steps we may analyze risks and estimate the kind of dangers, as well as their importance both in the present and in the future, or, in other words, an evaluation of potential risks is done. The purpose of such an evaluation of potential risks is to finally know if there is urgency in any undertaking, to deduce risk-combating measures and, in the case of serious contamination, a remedial strategy.

*Risk analysis* is done by historically investigating the potentially contaminated site (prior usage, soil occupation, etc.).

A technical analysis is then undertaken, with different methods and techniques, with the purpose of examining the current state of the site. Probes and samples are taken, which are then analyzed in order to determine the type, placement, quantity and concentration of any substance dangerous to the environment. The pursuit focuses on knowing both effective and possible threats, their transportation and evolution across time.

*Risk evaluation* must be able to answer the question "what is tolerable?", or evaluate what is admissible. In order to do this, risk analysis results are evaluated and compared to set objectives in order to protect the various goods and the environment in its ensemble. They are based on scientific knowledge and social value scales, comprising qualitative and quantitative criteria that define when alternations are no longer tolerable. Legal basis is required, adequate legislation, that contains indicative values and thresholds, clear and concise recommendations in order to evaluate contaminated sites.

The movement of dangerous substances at a site, contaminated by various ways (food chains, airborne, waterborne, direct contact) encompasses several environmental risks.

Thus, based on availability of dangerous substances and their different behavior and different contamination paths, an analysis and evaluation of risk based on substance, contamination type and goods to be protected proves indispensable. It is up to risk evaluation to judge in its entirety the interaction of different sectors over the environment.

When we know what is tolerable, an estimate can be made of potential risks, and then, judicious measures can be taken on the contaminated site. Such a risk evaluation is of course a process that reaches multiple domains, and warrants the inter-disciplinary participation of specialists.

The term *response* refers to any action which takes place during an emergency, both while it is in effect, and after, in order to reduce its negative effects on human health, economic activities and the environment.

*Responses* to risks are either to prevent or to limit consequences to the population. They are contained, by variable mixes and dosages, in the quadrilateral:

*Technical responses* – reveal different ranches of engineering studies; their main objective is, if complete annulment of risk is impossible, lessening the intensity of natural risks and limiting the possibility of technological risks. They are civil engineering feats, but their efficiency is still relative.

*Spacial improvement responses* – are of a preventive nature, destined to limit the vulnerability of territories subject to risks; they have a double juridical control: at authorization level, and another which focuses on eliminating any form of vulnerability which arises from urbanization. These two types of control lead to a more strict or lenient form of constructibility, being often a source of conflicts between public and private interest, between the State and local communities.

*Management responses* – come from institutions or civil protection organisms; they interfere during and after an extreme event to control it and remove consequences; their actions are practical reflections of operational help and intervention plans, which are reviewed based on experience gained from past catastrophes; the weak link is still the difficulty in reacting to an event that has escaped all prediction, the radically unpredictable.

*Insurance responses* – have as an essential purpose the repair of damages suffered after an event, by compensating victims; a current food-for-thought theme currently resides with the role that the insurer can have before the event, therefore in preventing (by modulating the values of insurance policies based on the potential risk, but also by technical exigences, contributing to applying indispensable security norms).

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|---|---|---|---|
| **Natural Hazards** | *geological* | | -earthquakes<br>-volcanoes |
| | | **Climate** | -typhoons<br>-hurricanes<br>-cold waves<br>-hot wave<br>-drought.<br>- waves |
| | *geographical* | **Oceanographic** | - tsunami |
| | | **Hydrological** | - El Niño<br>-folding<br>-fluvial processes |
| | | **geomorphological** | -mass displacements (landslides, mud flow etc.)<br>-erosion<br>-desertification |
| | *ecological* | | -species biodiversity |
| | *biological* | | -epidemics<br>-invasion of locusts |
| | *technological* | | -technical progress<br>-pollution |
| **Anthropogenic Hazard** | *social* | | -radioactivity<br>-population growth<br>-urbanization<br>-unemployment |

**Table 1.**